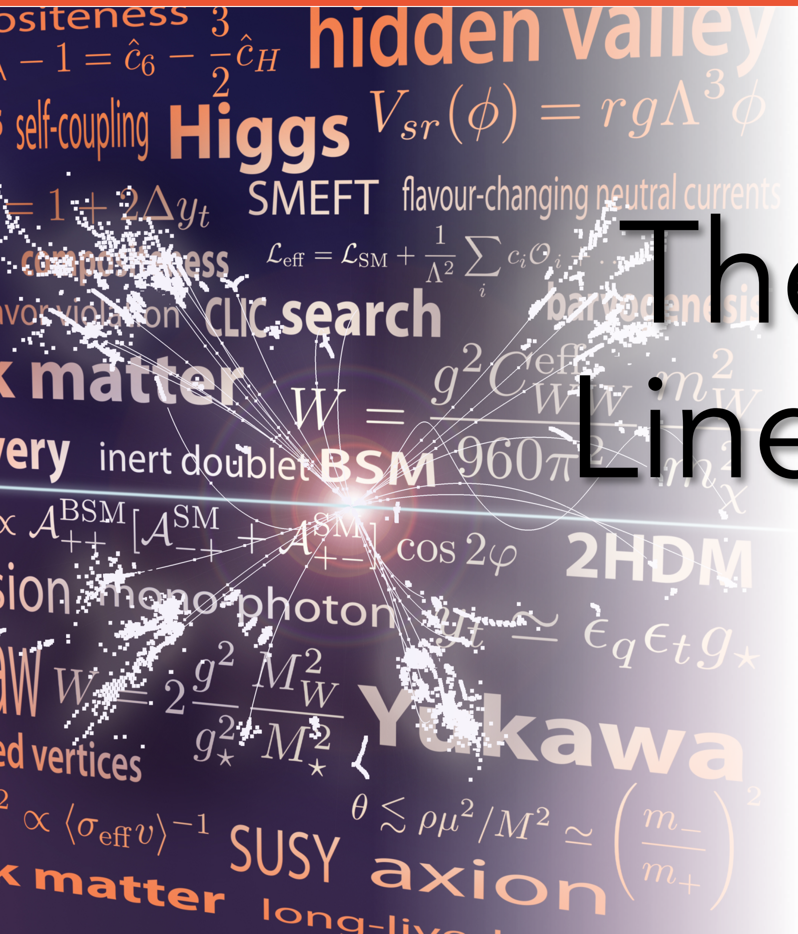
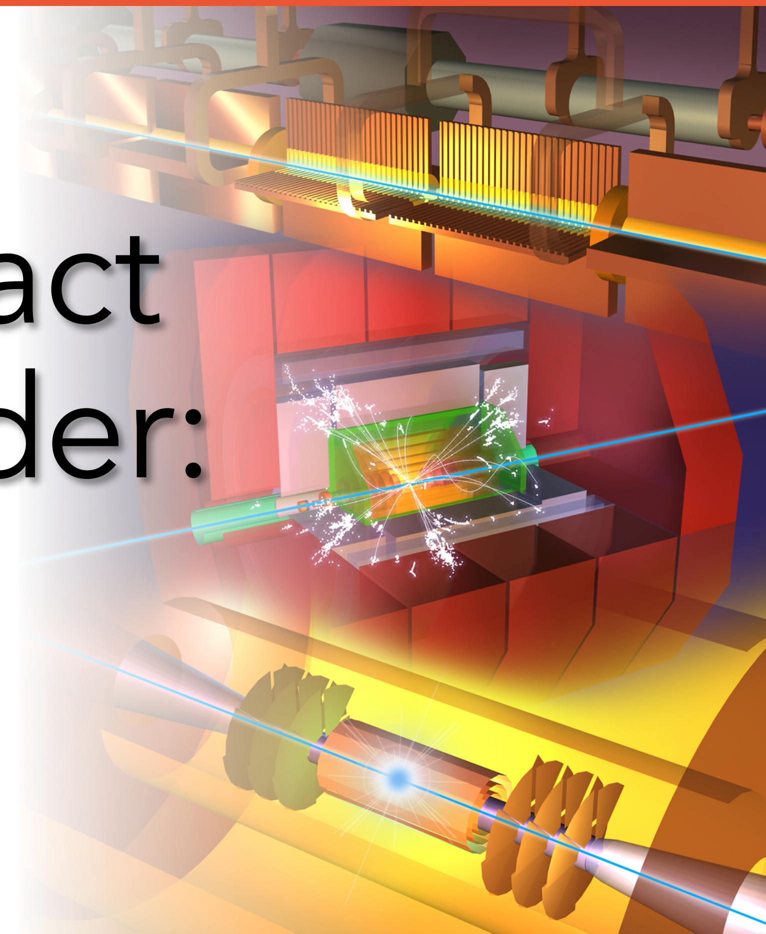


The Compact Linear Collider: CLIC

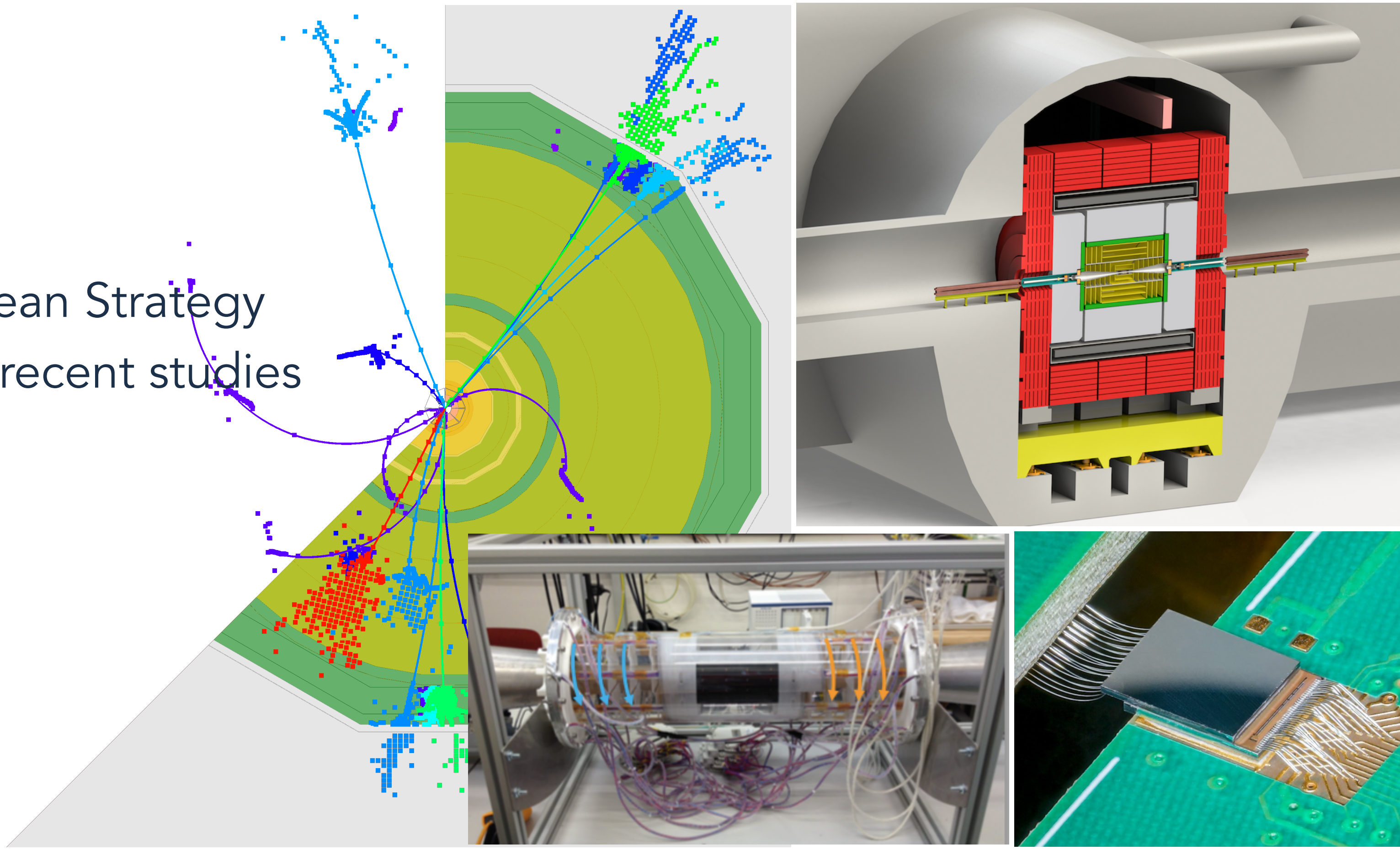


Snowmass Energy Frontier Workshop, 20 July 2020
Open Questions and New Ideas

Aidan Robson, University of Glasgow

CLIC

- Project overview
- Status after European Strategy
- Physics reach and recent studies
- How to contribute
- Outlook



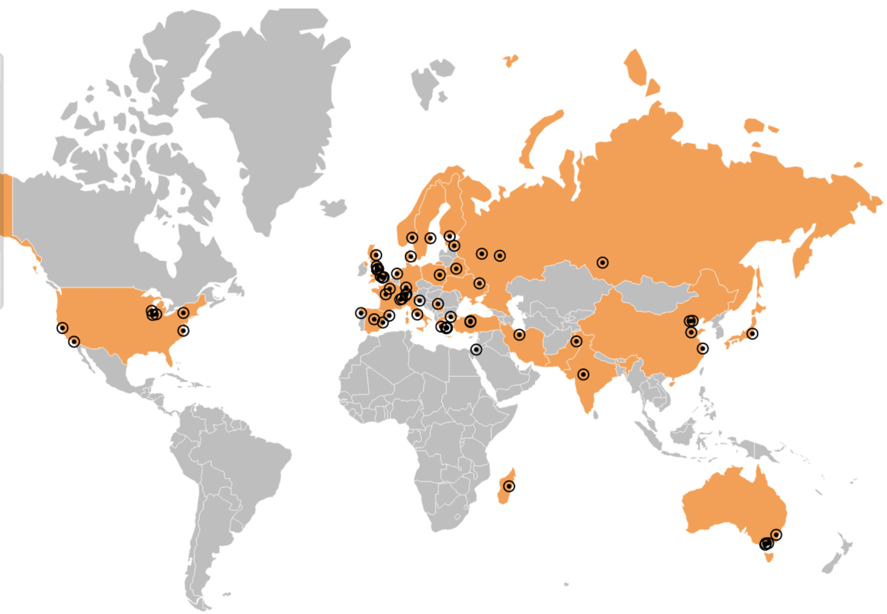
Compact Linear Collider:
e^+e^- collisions up to 3TeV
http://clic.cern/

Collaborations

http://clic.cern/

CLIC accelerator collaboration
~60 institutes from 28 countries

CLIC accelerator studies:
- CLIC accelerator design and development
- (Construction and operation of CLIC Test Facility, CTF3)

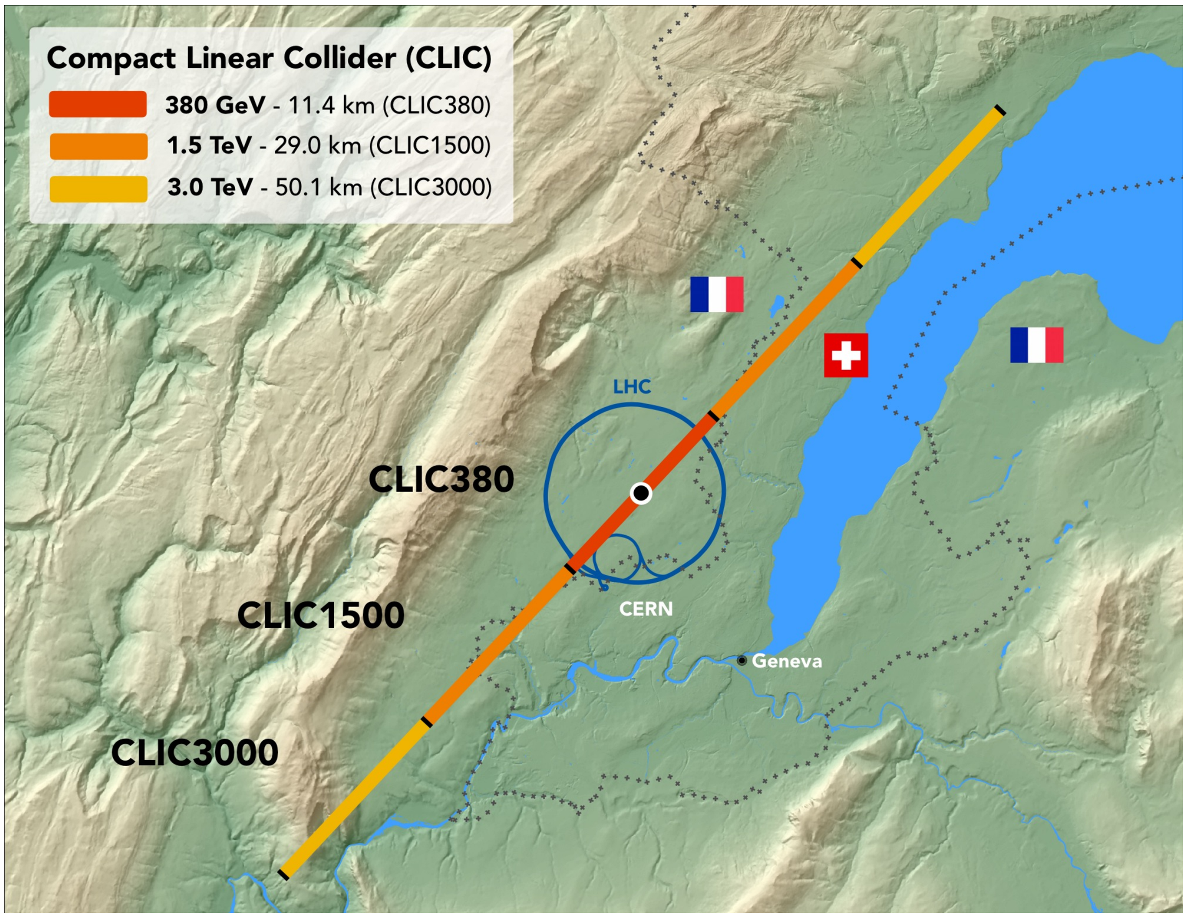


CLIC detector and physics (CLICdp)
30 institutes from 18 countries

Focus of CLIC-specific studies on:
- Physics prospects & simulation studies
- Detector optimization + R&D for CLIC

The Compact Linear Collider

- A high-luminosity, multi-TeV electron–positron collider
- Planned for construction at CERN in three energy stages:



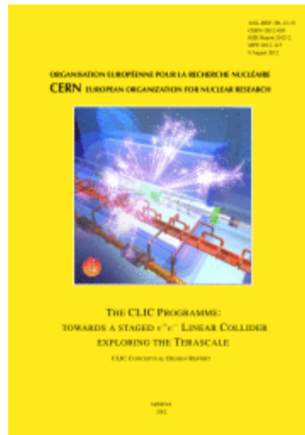
- 380GeV, focusing on precision Higgs boson and top-quark physics
- 1.5 and 3TeV, expanding Higgs and top studies including Higgs self-coupling, and opening higher direct and indirect sensitivity to Beyond Standard Model (BSM)
- Nominal physics programme lasts for 25–30 years; approvable in stages
- Benefit of linear machine: length/energy staging plan can be updated in response to developing physics landscape

CLIC History

- 3-volume CDR 2012

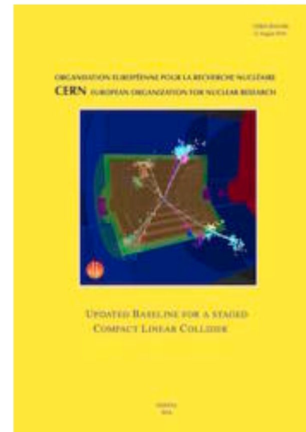
Accelerator

Physics & Detectors



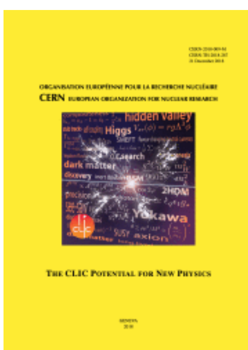
Strategy & Implementation

Updated Staging Baseline 2016

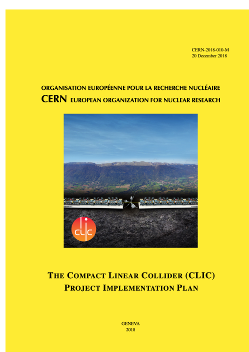


- 4 Yellow Reports 2018

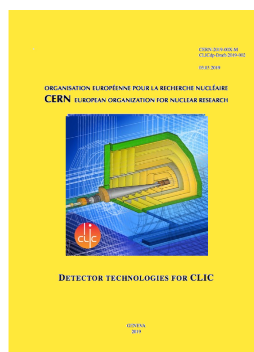
Summary Report



Physics Potential



Project Implementation



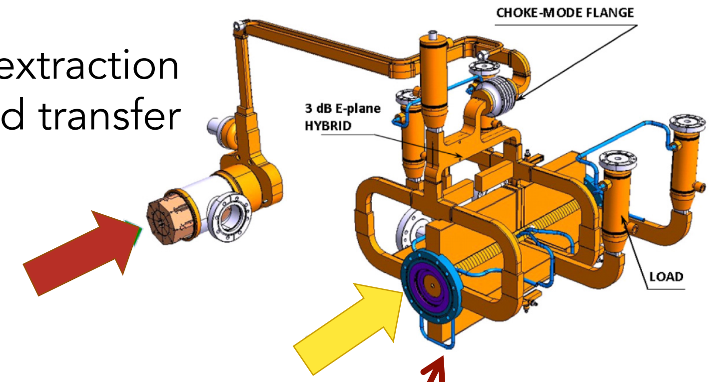
Detector Technologies

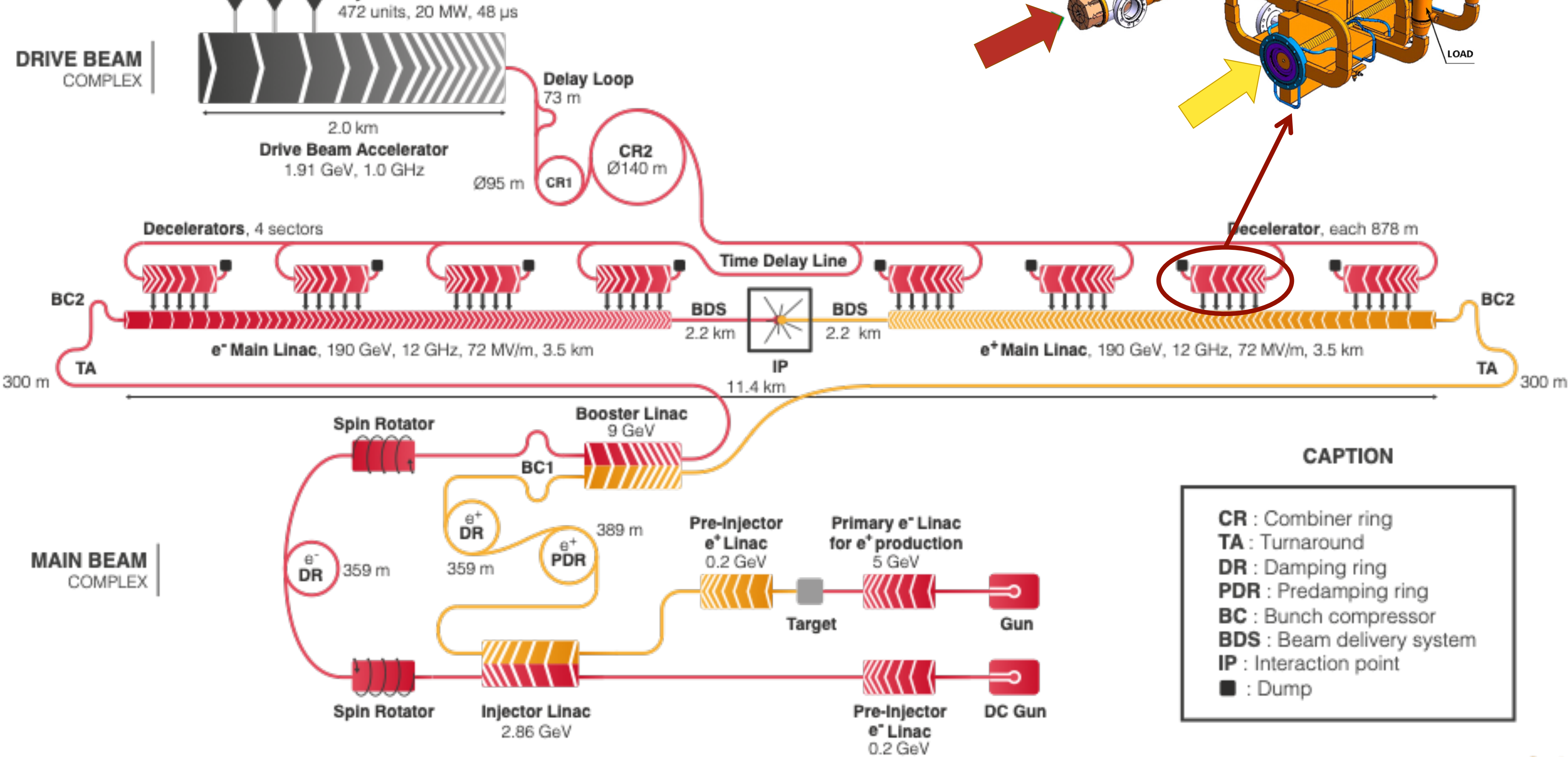
- CLIC is now a mature project – technical timeline gives readiness for construction starting ~2026, with first collisions ~2035

CLIC at 380GeV

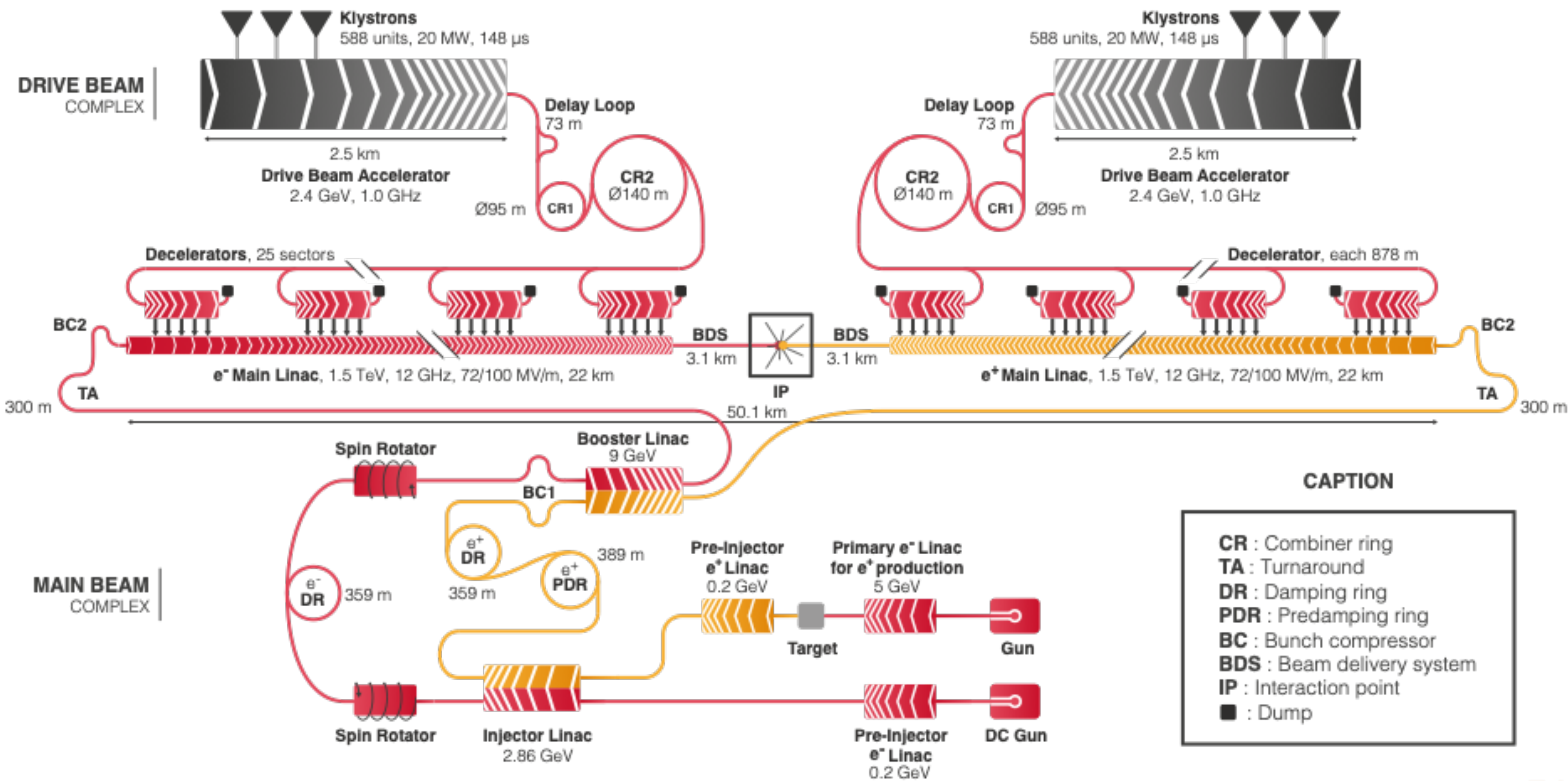
- Two-beam acceleration scheme

Power extraction and transfer





CLIC at 3TeV

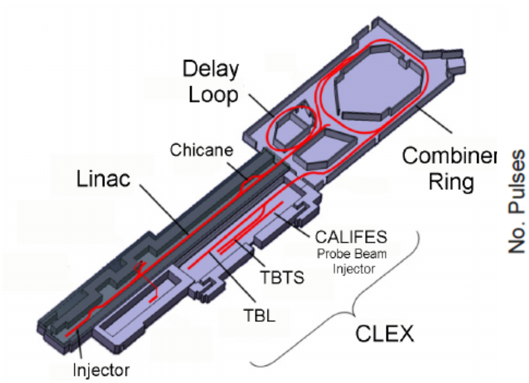


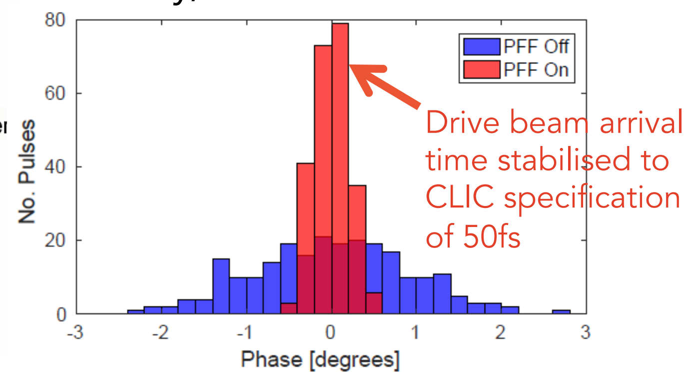
DRIVE BEAM COMPLEX
Klystrons
588 units, 20 MW, 148 μs
2.5 km
Drive Beam Accelerator
2.4 GeV, 1.0 GHz
Delay Loop
73 m
CR2
Ø140 m
CR1
Ø95 m
Decelerators, 25 sectors
Decelerator, each 878 m
BC2
TA
300 m
e⁻ Main Linac, 1.5 TeV, 12 GHz, 72/100 MV/m, 22 km
e⁺ Main Linac, 1.5 TeV, 12 GHz, 72/100 MV/m, 22 km
BDS
3.1 km
IP
50.1 km
MAIN BEAM COMPLEX
Spin Rotator
Booster Linac
9 GeV
BC1
e⁺ DR
e⁺ PDR
389 m
359 m
e⁻ DR
359 m
Pre-Injector e⁺ Linac
0.2 GeV
Target
Primary e⁻ Linac for e⁺ production
5 GeV
Gun
Injector Linac
2.86 GeV
Pre-Injector e⁻ Linac
0.2 GeV
DC Gun
CAPTION
CR : Combiner ring
TA : Turnaround
DR : Damping ring
PDR : Predamping ring
BC : Bunch compressor
BDS : Beam delivery system
IP : Interaction point
■ : Dump

Accelerator challenges

High-current drive beam bunched at 12 GHz

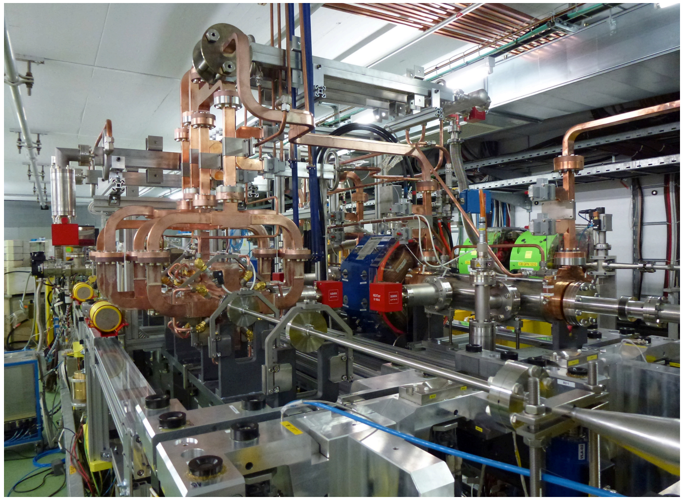
Produced at CLIC Test Facility CTF3, now the 'CERN Linear Electron Accelerator for Research' facility, CLEAR





Power transfer + main-beam acceleration

Demonstrated 2-beam acceleration



~100 MV/m gradient in main-beam cavities

Achieved in structures produced by different sources

Alignment & stability

The CLIC strategy:

- Alignment; vibration damping; good beam measurement and feedback
- Tests in small accelerators of equipment and algorithms (FACET at Stanford, ATF2 at KEK, CTF3, Light-sources)

–> Key accelerator technologies have been demonstrated

For more on accelerator, see talk from Steinar Stapnes at June joint Snowmass AF/EF session: https://indico.fnal.gov/event/43871/

CLIC status after European Strategy

- European Strategy for Particle Physics was updated in June after a several-year process:
– prioritises an electron–positron Higgs factory as the next collider
– articulates the ambition to operate a proton–proton collider at the highest achievable energy
– mandates a technical and financial feasibility study for a 100TeV collider
– mandates intensified accelerator R&D, including on high-gradient structures

- Over the next 5 years CERN will continue the investment in R&D for key technologies related to CLIC

–> CLIC is maintained so that if in 2026 the feasibility study is not conclusive for FCC then CLIC could be implemented in an expeditious way.

- CLIC is the least-expensive Higgs factory proposed for construction in Europe, and leads to unique physics potential at high energy running

High-energy lepton collisions

- Over the next 5 years CLIC accelerator research will include:
  - high-gradient accelerating structures at the X-box test facility
  - operation of the CLEAR facility; beam tests and beam instrumentation;
  - beam dynamics studies;
  - high-efficiency klystron development

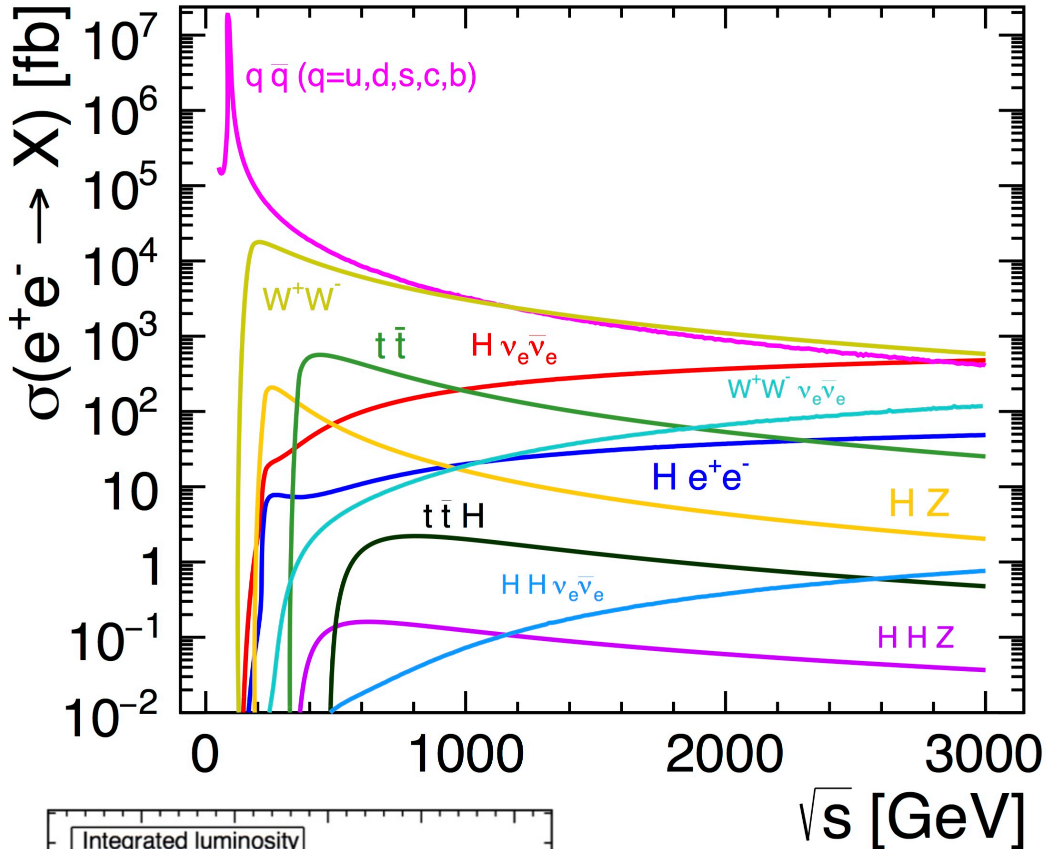
  Accelerator R&D continues –> CLIC physics remains very relevant

- Growing interest in high-energy lepton collisions:
  - 3 presentations on wakefield accelerator concepts, plus one on cold normal-conducting linear collider at joint EF/AF meeting
  - muon collider collaboration initiating (see talk from Donatella Lucchesi)

  –> CLIC is by far the most advanced TeV-scale lepton collider considered, and the only one where detailed physics studies have been done.

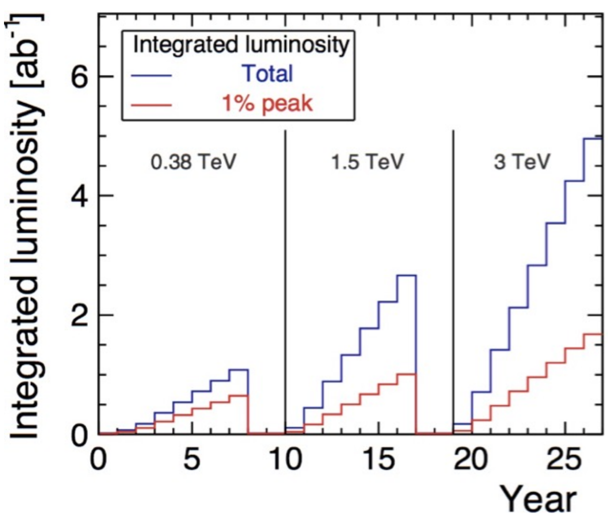
–> physics of high-energy lepton collisions should be a central part of Snowmass considerations

Physics processes and staging



- 2-fermion production e.g. $q\bar{q}$
- WW production
- Higgsstrahlung (HZ):
  - best at 240–380 GeV: "Higgs factory"
- $t\bar{t}$ threshold: 350 GeV
- $t\bar{t}$ continuum: >365 GeV
- Double Higgsstrahlung (HHZ):
  - cross-section maximum ~600 GeV
- Single and double Higgs in WW fusion ($H\nu_e\bar{\nu}_e$ and $HH\nu_e\bar{\nu}_e$):
  - cross-section rises with energy
- Direct searches for new particles:
  highest possible energy

–> Best explored in several energy stages



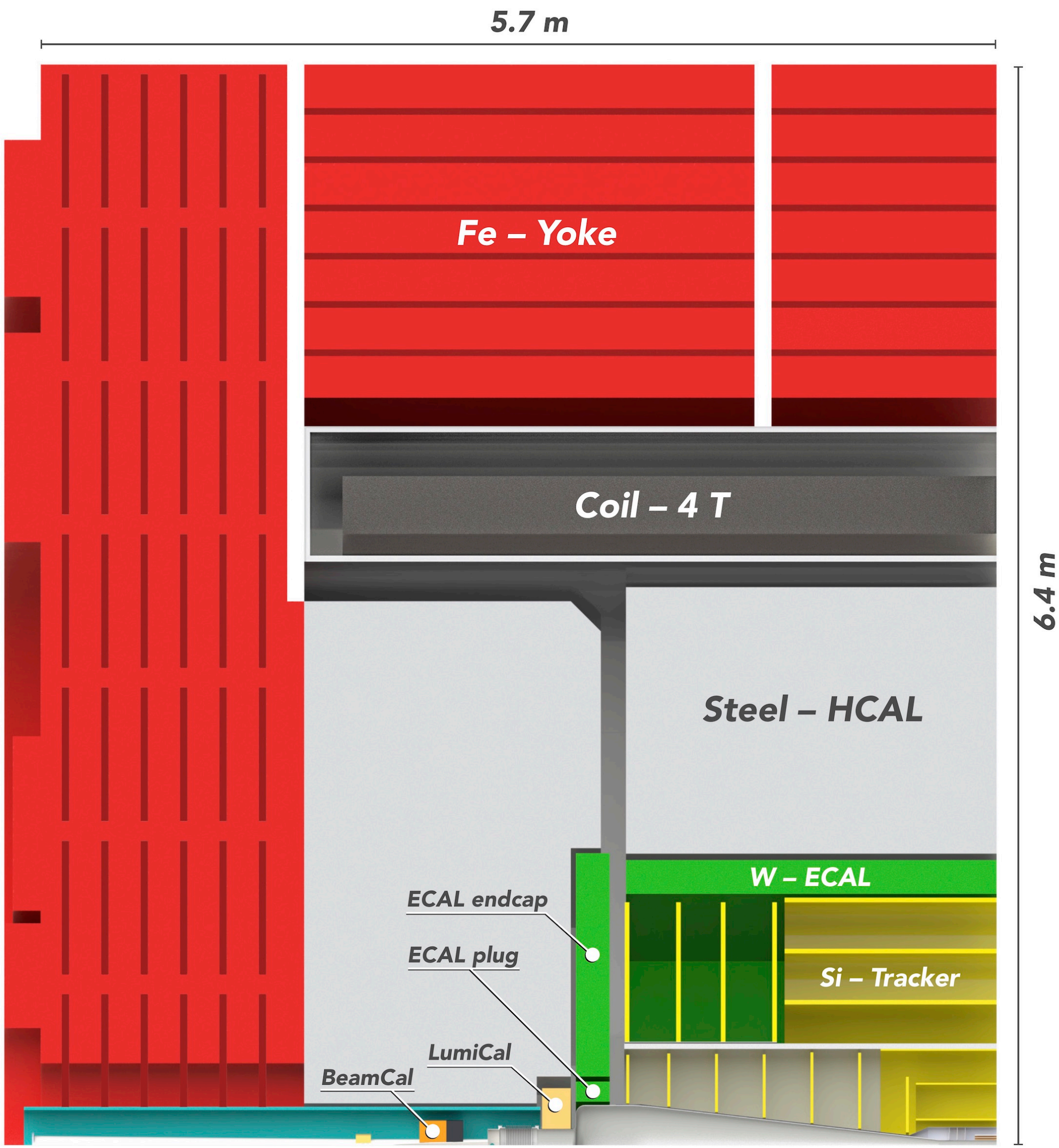
Stage	$\sqrt{s}$ [TeV]	$\mathscr{L}_{int}$ [ab^{-1}]
1	0.38 (and 0.35)	1.0
2	1.5	2.5
3	3.0	5.0

Polarised electron beam (–80%, +80%)

Ratio (50:50) at $\sqrt{s}$=380GeV ; (80:20) at $\sqrt{s}$=1.5 and 3TeV

Baseline staging scenario emphasis is on getting to multi-TeV collisions quickly

CLIC Detector Concept



Essential characteristics:

- B-field: 4T
- Vertex detector with 3 double layers
- Silicon tracking system: 1.5m radius
- ECAL with 40 layers (22 X_0)
- HCAL with 60 layers (7.5 λ)

Precise timing for background suppression (bunch crossings 0.5ns apart)

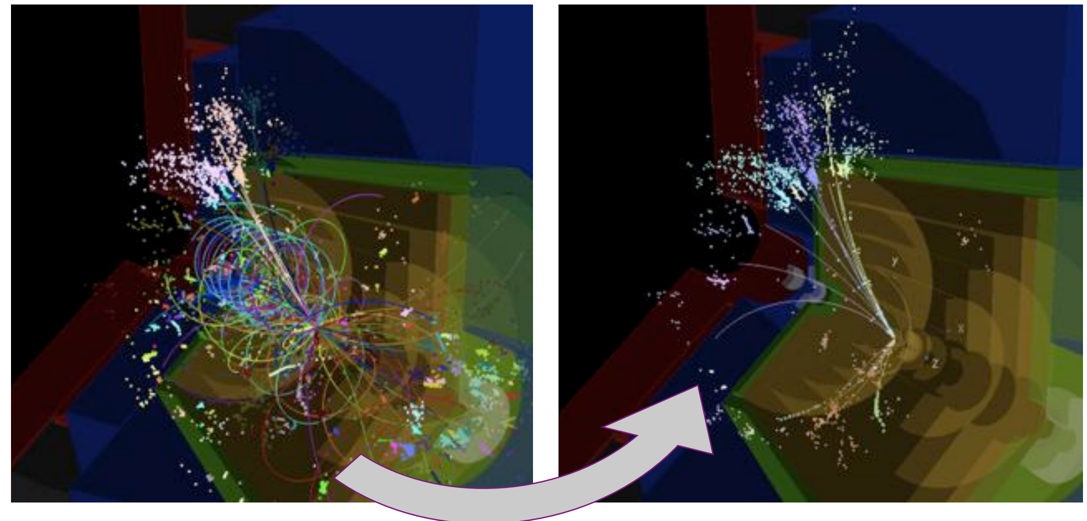
- ~10ns hit time-stamping in tracking
- 1ns accuracy for calorimeter hits

CLICdp-Note-2017-001
arXiv:1812.07337

+ Dedicated detector R&D programme, particularly on Vertex & Tracking

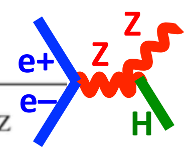
Higgs coupling sensitivity

- Extensive set of full GEANT-based simulation studies including beam backgrounds done for Higgs sector
- Full simulation: imaging calorimetry allows e.g. H->bb/cc/gg separation
- Model-independent coupling extraction
  arXiv:1812.01644
  based on Eur. Phys. J. C 77, 475 (2017)
- Sensitivities used as input for EFT fits



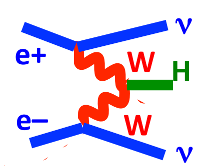
timing/momentum cuts

Channel	Measurement	Observable	Statistical precision 350GeV $1\,\mathrm{ab}^{-1}$
ZH	Recoil mass distribution	m_{H}	78MeV
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \text{invisible})$	Γ_{inv}	0.4%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{Z} \to \mathrm{l}^+\mathrm{l}^-)$	g^2_{HZZ}	2.7%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{Z} \to \mathrm{q}\bar{\mathrm{q}})$	g^2_{HZZ}	1.3%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	0.61%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \mathrm{c}\bar{\mathrm{c}})$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{Hcc}}/\Gamma_{\mathrm{H}}$	10%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \mathrm{gg})$		4.3%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \tau^+\tau^-)$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{H\tau\tau}}/\Gamma_{\mathrm{H}}$	4.4%
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \mathrm{WW}^*)$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{HWW}}/\Gamma_{\mathrm{H}}$	3.6%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	1.3%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{c}\bar{\mathrm{c}})$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{Hcc}}/\Gamma_{\mathrm{H}}$	18%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{gg})$		7.2%



Many channels studied

Channel	Measurement	Observable	Statistical precision 1.4TeV $2.5\,\mathrm{ab}^{-1}$	3TeV $5.0\,\mathrm{ab}^{-1}$
$\mathrm{H}\nu_e\bar{\nu}_e$	$\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}}$ mass distribution	m_{H}	36MeV	28MeV
ZH	$\sigma(\mathrm{ZH}) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	2.6%†	4.3%†
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	0.3%	0.2%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{c}\bar{\mathrm{c}})$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{Hcc}}/\Gamma_{\mathrm{H}}$	4.7%	4.4%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{gg})$		3.9%	2.7%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \tau^+\tau^-)$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{H\tau\tau}}/\Gamma_{\mathrm{H}}$	3.3%	2.8%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mu^+\mu^-)$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{H\mu\mu}}/\Gamma_{\mathrm{H}}$	29%	16%
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \gamma\gamma)$		12%	6%*
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{Z}\gamma)$		33%	19%*
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{WW}^*)$	$g^4_{\mathrm{HWW}}/\Gamma_{\mathrm{H}}$	0.8%	0.4%*
$\mathrm{H}\nu_e\bar{\nu}_e$	$\sigma(\mathrm{H}\nu_e\bar{\nu}_e) \times BR(\mathrm{H} \to \mathrm{ZZ}^*)$	$g^2_{\mathrm{HWW}} g^2_{\mathrm{HZZ}}/\Gamma_{\mathrm{H}}$	4.3%	2.5%*
$\mathrm{He}^+\mathrm{e}^-$	$\sigma(\mathrm{He}^+\mathrm{e}^-) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{HZZ}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	1.4%	1.5%*
$\mathrm{t}\bar{\mathrm{t}}\mathrm{H}$	$\sigma(\mathrm{t}\bar{\mathrm{t}}\mathrm{H}) \times BR(\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}})$	$g^2_{\mathrm{Htt}} g^2_{\mathrm{Hbb}}/\Gamma_{\mathrm{H}}$	5.7%	–



(These precisions are for unpolarised beams; baseline is on slide 11) † : fast simulation *: extrapolated from 1.4TeV

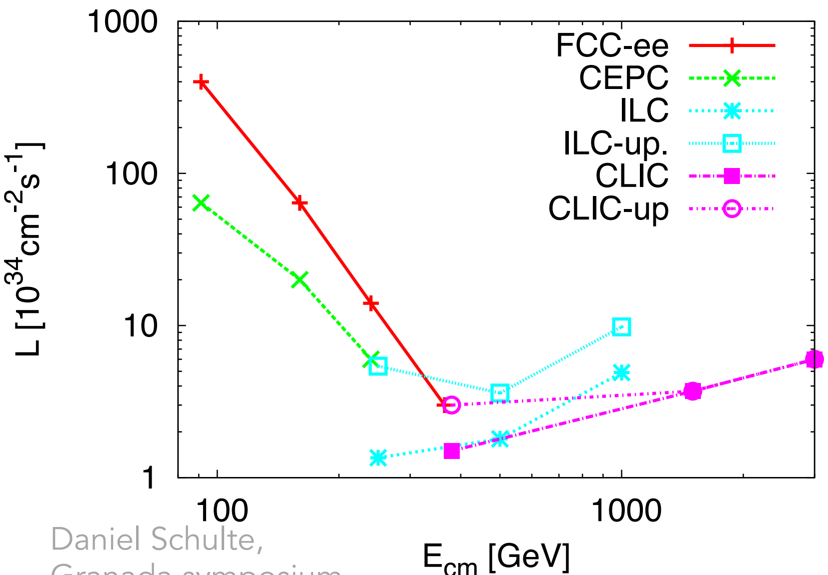
Alternative run scenario

- To illustrate the flexibility of the run-plan: two modifications with respect to the baseline staging:

- **Doubling bunch train repetition rate at initial stage from 50Hz to 100 Hz**
–> modest increase in cost (~5%) and power (from 170MW to 220MW)
CERN-ACC-2019-0051

- **Increasing initial stage from 8 to 13 years**

–> Integrated luminosity at 380GeV increases from $1ab^{-1}$ to $4ab^{-1}$



Daniel Schulte, Granada symposium

	Benchmark	HL-LHC	HL-LHC + CLIC 380 ($4\,ab^{-1}$)	HL-LHC + CLIC 380 ($1\,ab^{-1}$) + 1500 ($2.5\,ab^{-1}$)	HL-LHC + FCC-ee 240	HL-LHC + FCC-ee 365
$g^{\text{eff}}_{HZZ}[\%]$	SMEFT_{ND}	3.6	0.3	0.2	0.5	0.3
$g^{\text{eff}}_{HWW}[\%]$	SMEFT_{ND}	3.2	0.3	0.2	0.5	0.3
$g^{\text{eff}}_{H\gamma\gamma}[\%]$	SMEFT_{ND}	3.6	1.3	1.3	1.3	1.2
$g^{\text{eff}}_{HZ\gamma}[\%]$	SMEFT_{ND}	11.	9.3	4.6	9.8	9.3
$g^{\text{eff}}_{Hgg}[\%]$	SMEFT_{ND}	2.3	0.9	1.0	1.0	0.8
$g^{\text{eff}}_{Htt}[\%]$	SMEFT_{ND}	3.5	3.1	2.2	3.1	3.1
$g^{\text{eff}}_{Hcc}[\%]$	SMEFT_{ND}	–	2.1	1.8	1.4	1.2
$g^{\text{eff}}_{Hbb}[\%]$	SMEFT_{ND}	5.3	0.6	0.4	0.7	0.6
$g^{\text{eff}}_{H\tau\tau}[\%]$	SMEFT_{ND}	3.4	1.0	0.9	0.7	0.6
$g^{\text{eff}}_{H\mu\mu}[\%]$	SMEFT_{ND}	5.5	4.3	4.1	4.	3.8
$\delta g_{1Z}[\times 10^2]$	SMEFT_{ND}	0.66	0.027	0.013	0.085	0.036
$\delta\kappa_\gamma[\times 10^2]$	SMEFT_{ND}	3.2	0.032	0.044	0.086	0.049
$\lambda_Z[\times 10^2]$	SMEFT_{ND}	3.2	0.022	0.005	0.1	0.051

CLIC longer first stage

CLIC baseline

From arXiv: 2001.05278

From European Strategy Briefing Book

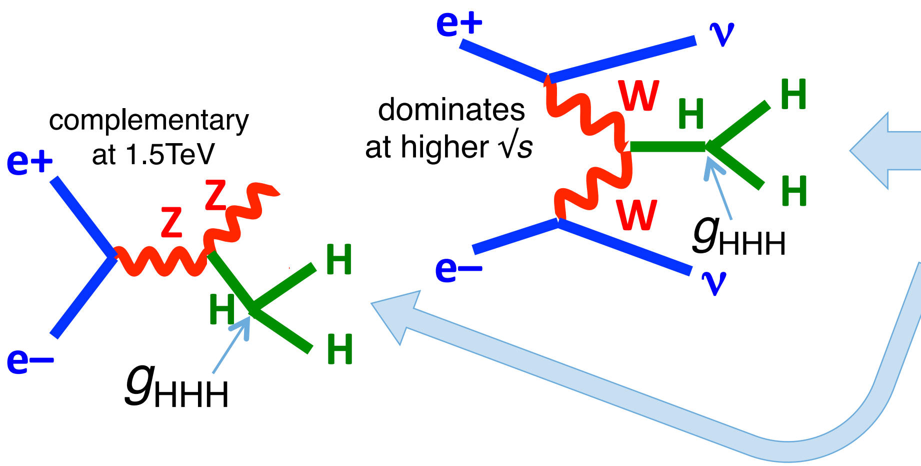
- Either scenario (longer 1st stage, or baseline 1st+2nd stage) very competitive

- Proposed e+e– colliders give similar Higgs performance at the initial stage "Higgs Factory"

–> look at what is unique to CLIC

Higgs self-coupling, and ZH at 3TeV

◆ High-energy running gives direct access to Higgs self-coupling



	1.4TeV	3TeV
$\sigma(HH\nu_e\bar{\nu}_e)$	>3σ EVIDENCE $\frac{\Delta\sigma}{\sigma}$ = 28%	>5σ OBSERVATION $\frac{\Delta\sigma}{\sigma}$ = 7.3%
σ(ZHH)	3.3σ EVIDENCE	2.4σ EVIDENCE
g_{HHH}/g^{SM}_{HHH}	1.4TeV: –34%, +36% rate-only analysis	1.4 + 3TeV: –8%, +11% differential analysis

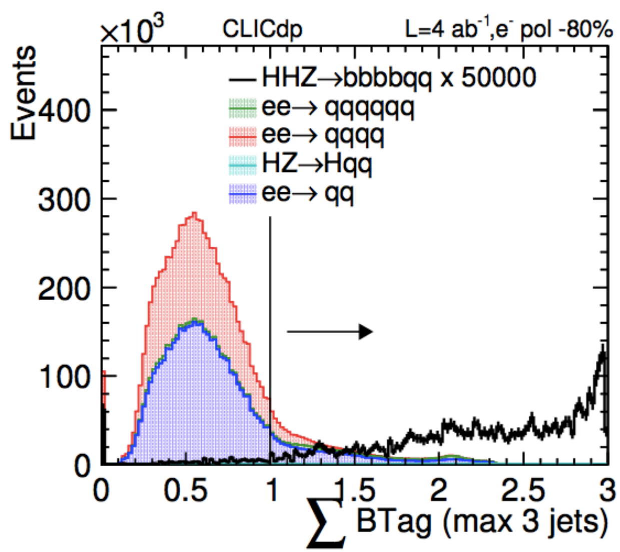
arXiv:1901.05897 updated with new full-sim ZHH study

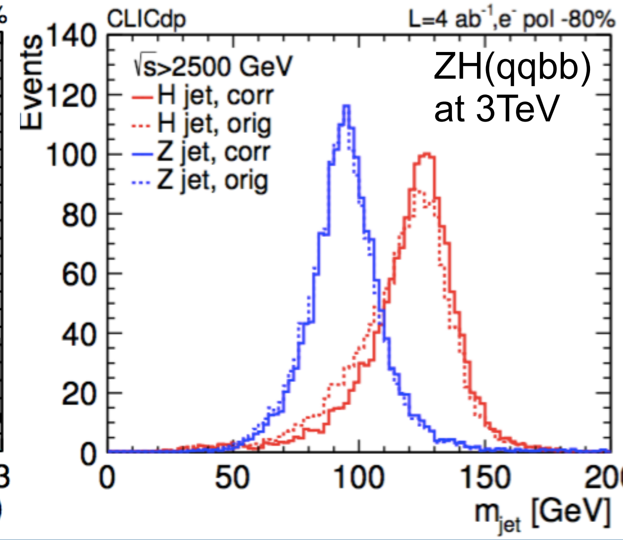
◆ Direct access to two processes that behave differently with non-SM values of self-coupling

◆ Recently-completed high-energy studies

ZHH and ZH(qqbb) at 3 TeV to confirm fast simulation / extrapolation
- use of jet substructure
- first use of b-tagging in boosted Higgs decays at CLIC

Also ongoing in full simulation: WW production ; H rare decays H->ZZ at high energy

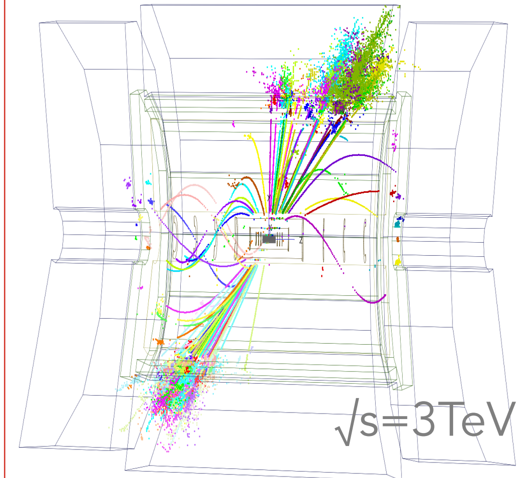




Top-quark physics

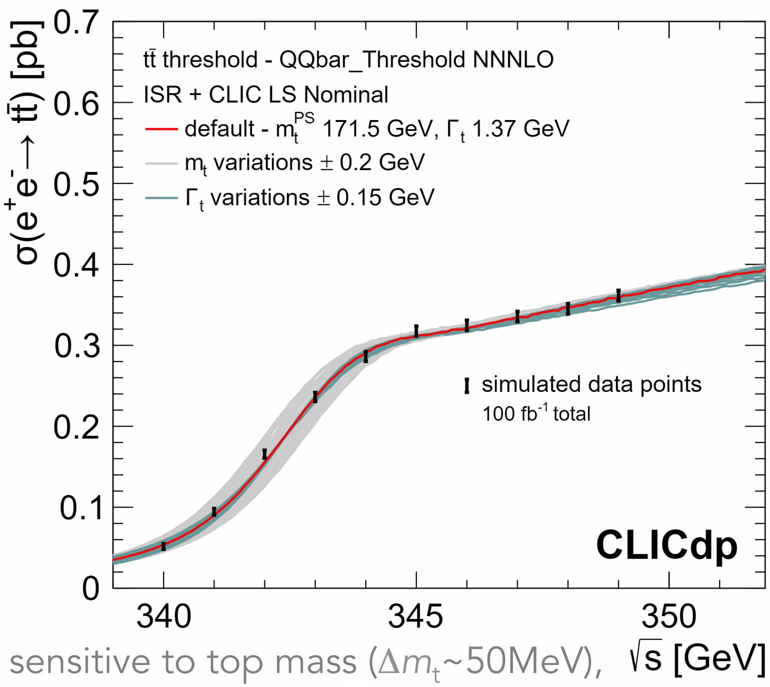
- **CLIC is unique among e+e– colliders by accessing top-quark physics from the initial energy stage**

First study of boosted top production in e^+e^-

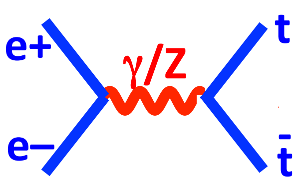


$e^+e^- \to t\bar{t} \to q\bar{q}q\bar{q}b\bar{b}$

- Threshold scan:



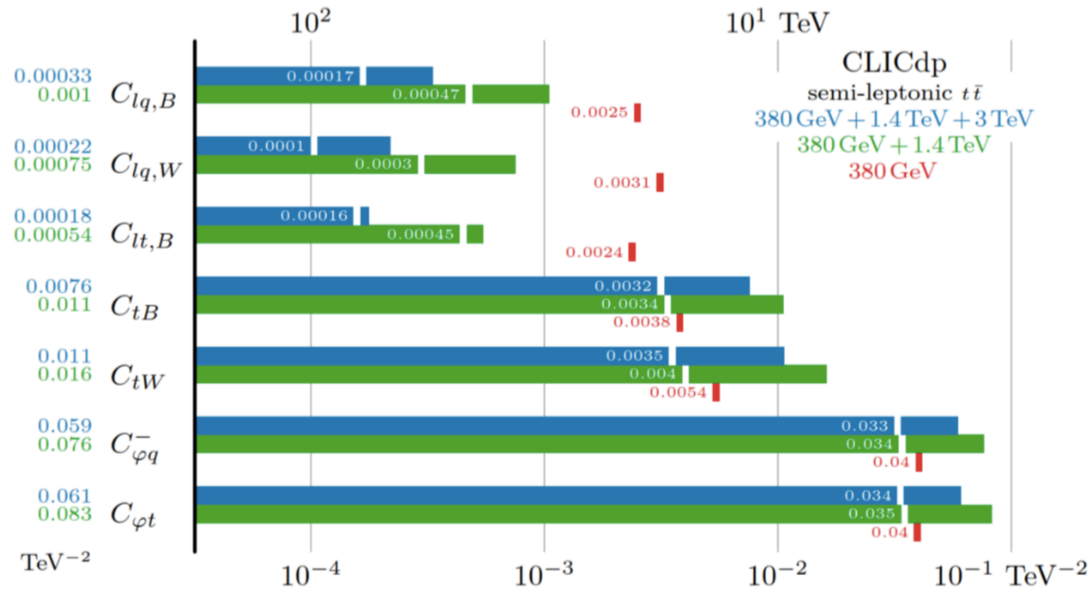
sensitive to top mass (Δm_t~50MeV), width, couplings



Electron beam polarisation provides new observables

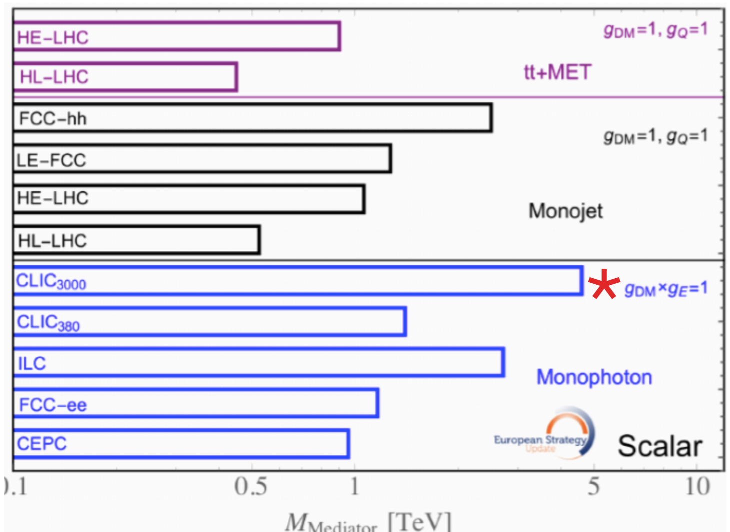
Top-quark physics at CLIC: JHEP11 (2019) 003

- Pair production:
  - Top cross-sections, both polarisations ~1%
  - Top forward-backward asymmetries ~3–4%
  - Statistically optimal observables for top EWK couplings; more than one energy stage allows global fit

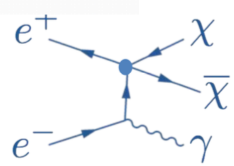


BSM direct searches

◆ Examples of recent search studies for European Strategy:



◆ **Dark matter:**

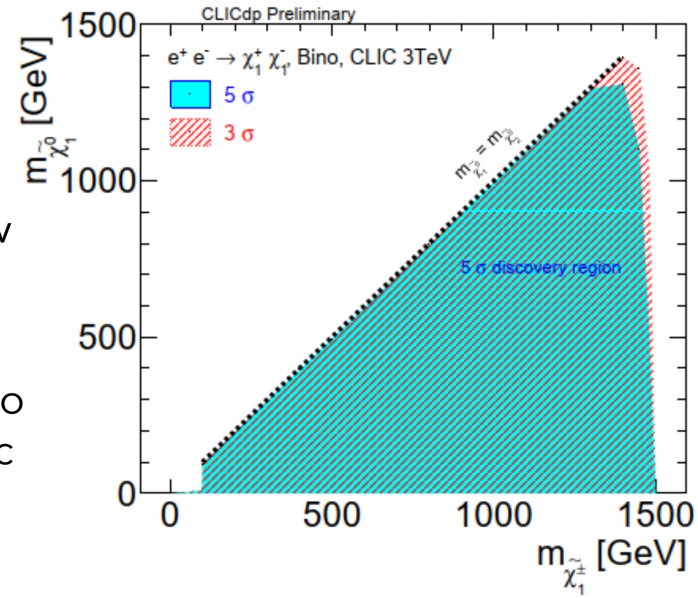


Searching for simplified model dark matter scalar mediator using mono-photon signature –> higher mass reach

◆ **SUSY signatures:**

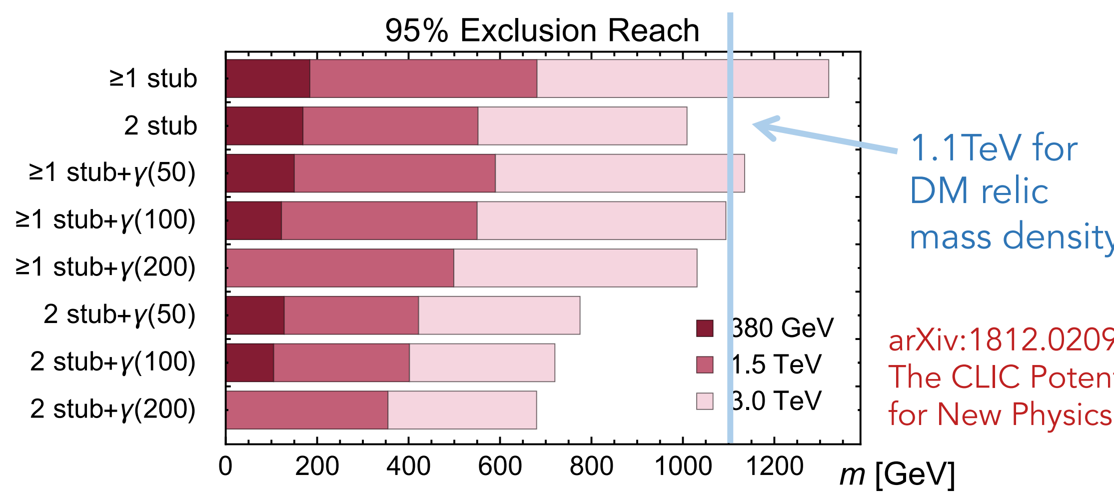
$e^+e^- \rightarrow \chi_1^+ \chi_1^-$
with $\chi_1^\pm \rightarrow \chi_1^0 W^\pm$
and $W^+W^- \rightarrow qqqq$
or $W^+W^- \rightarrow e^-\mu^+\nu\nu$
or $e^+\mu^-\nu\,\nu$

Scan of parameter space in R-parity conserving scenario –> larger kinematic coverage; difficult to access at LHC



◆ **Higgsino:**

With other superpartners decoupled:
$\chi^\pm$ slightly heavier than χ^0 ; $\chi^\pm \rightarrow \pi^\pm\chi^0$
leaving 'disappearing track' signature



arXiv:1812.02093
The CLIC Potential for New Physics

BSM effects through global EFT fits

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_i \frac{c_i}{\Lambda^2}\mathcal{O}_i$$

Standard Model

Scale of new decoupled physics

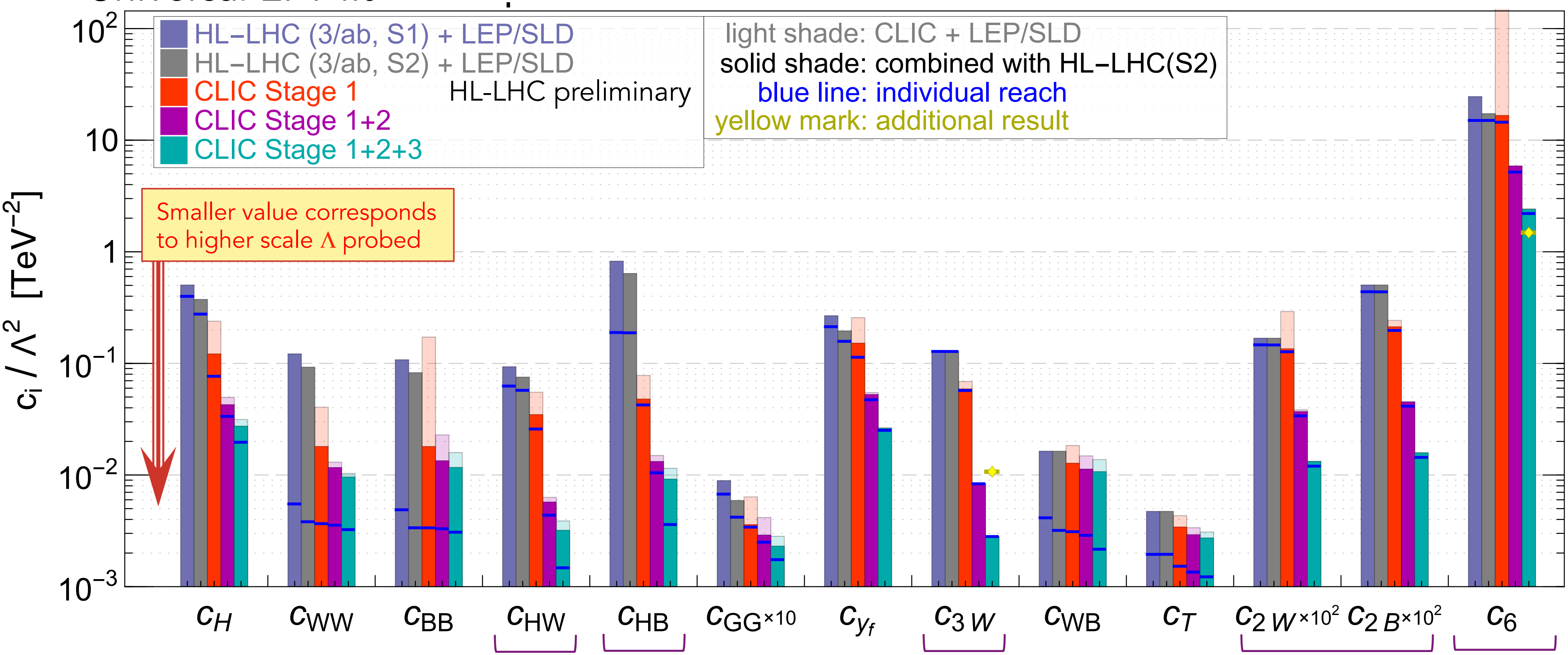
Dimension-6 operators

Includes CLIC measurements of:

- Higgs
- Top
- WW
- $e^+e^- \to f\bar{f}$

Strongly benefits from high-energy running

Universal EFT fit



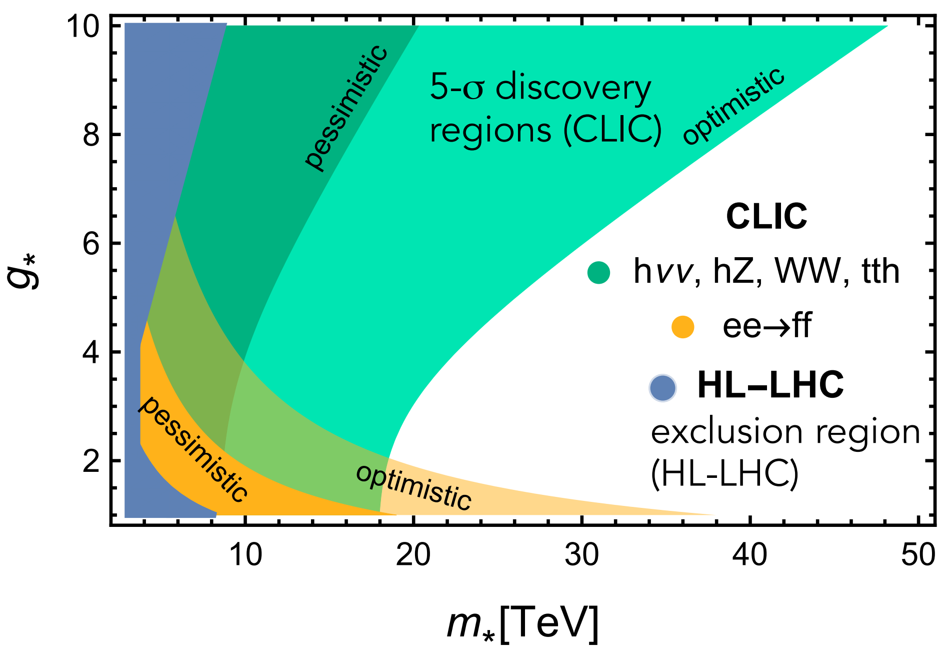
effects grow with energy

from $e^+e^- \to HH$

arXiv:1812.02093 The CLIC potential for new physics, CERN-2018-009-M

BSM indirect searches

◆ Composite Higgs (or top) would appear through SM-EFT operators – translate EFT limits into characteristic coupling strength g_* of composite sector and mass m_*

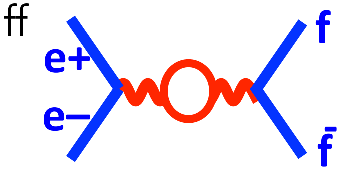


CLIC can ***discover*** compositeness up to ~10TeV compositeness scale (~30 – ~50TeV in favourable conditions) – above what HL-LHC can ***exclude***

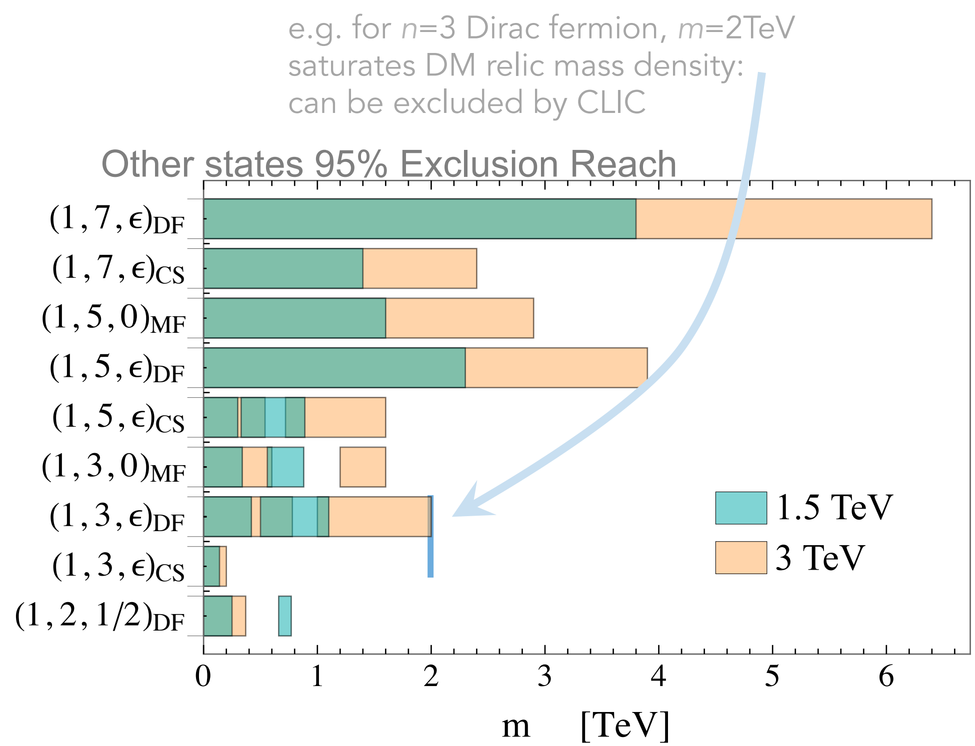
◆ Precision measurements e.g.

dσ/d(cosθ) in e^+e^- -> $f\bar{f}$

can be sensitive to new states –> excluded mass ranges



arXiv:1810.10993 - Di Luzio, Gröber, Panico

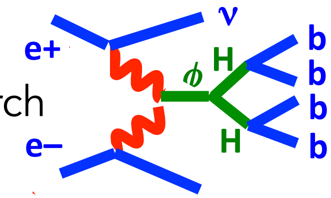


DF=Dirac Fermion, MF=Majorana Fermion, CS=Complex Scalar
SU(3)xSU(2)xU(1) representation; different *n*-tuplet multiplicities

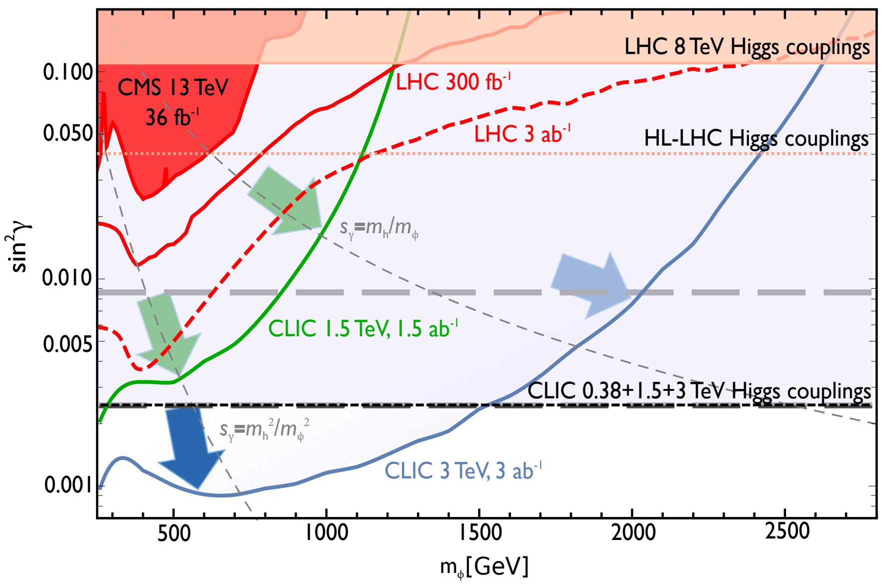
arXiv:1812.02093 The CLIC Potential for New Physics

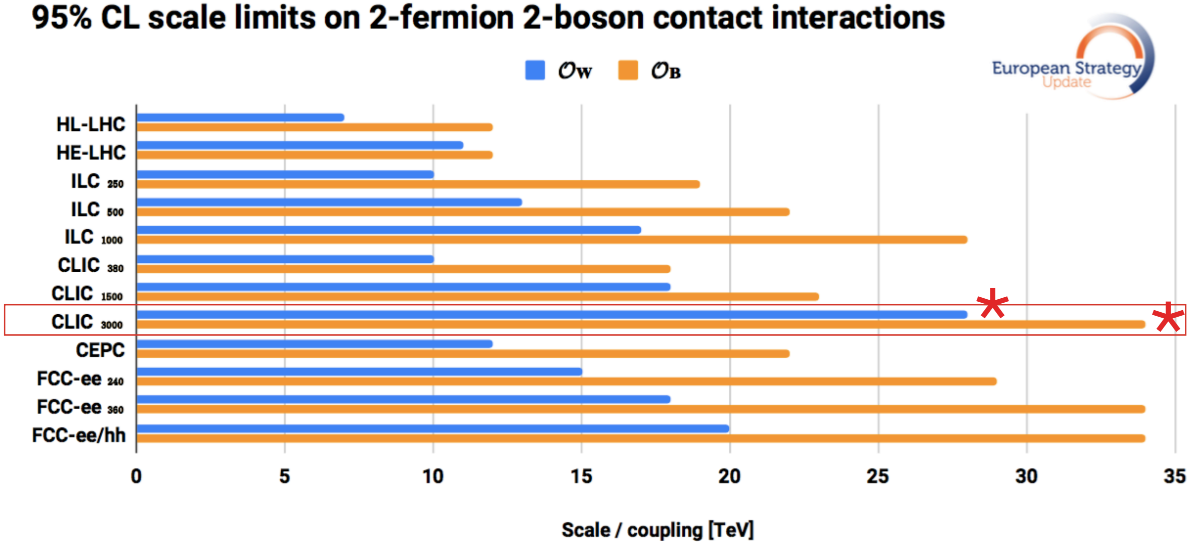
Interpretations and full programme

◆ Higgs + heavy singlet:
Complementarity of direct search and indirect constraints



◆ Contact interactions interpretations





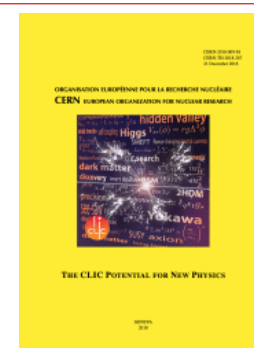
CLIC reaches ~28TeV in O_W, ~34TeV in O_B

Precision Higgs couplings and self-coupling
Precision electroweak and top-quark analysis
Sensitivity to BSM effects in the SMEFT
Higgs and top compositeness
Baryogenesis
Direct discoveries of new particles
Extra Higgs boson searches
Dark matter searches
Lepton and flavour violation
Neutrino properties
Hidden sector searches
Exotic Higgs boson decays

Many more studies in CERN Yellow Report:

The CLIC Potential for New Physics (250 pages)

arXiv:1812.02093 CERN-2018-009-M



Snowmass studies

- Preparing the CLIC Potential for New Physics Yellow Report, and the lead-up to the European Strategy Update Open Symposium provided a focus for phenomenology studies from a wide community

  –> good if Snowmass can do the same

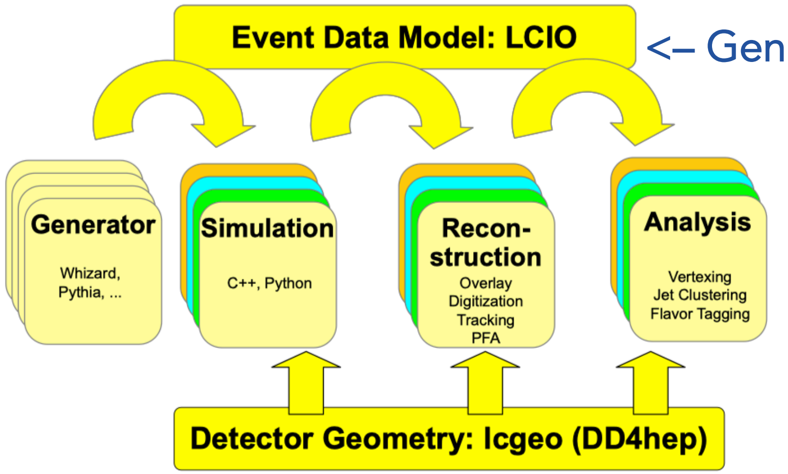
- High-energy lepton studies should be a feature of Snowmass physics considerations!

  Particular areas of focus beyond Higgs physics:

  - importance of top-quark physics in e+e–
  - importance of several energy stages in e+e–
  - direct searches, in particular for elusive signatures
  - further and novel ways of constraining NP from precision measurements
  - importance of beam polarisation
  - model realisations in multi-TeV lepton collisions

–> look at your favourite model at CLIC energies
–> please help obtain sensitivities for new Snowmass benchmarks that are defined!

Simulation/Reconstruction



<– Generic SW structure for detector optimisation and physics studies

Now	Future
iLCSoft	Key4hep
Marlin framework	GAUDI framework
LCIO event data model	EDM4hep/PODIO event data model

Detector	Collider	SW name	SW status	SW future
ILD	ILC	iLCSoft	Full sim/reco	Key4hep
SiD	ILC	iLCSoft	Full sim/reco	
CLICdet	CLIC	iLCSoft	Full sim/reco	
CLD	FCC-ee	iLCSoft	Full sim/reco	
IDEA	FCC-ee	FCC-SW	Fast sim/reco	
IDEA	CEPC	FCC-SW	Fast sim/reco	
CEPCbaseline	CEPC	iLCSoft branch-off	Full sim/reco	

Recommendation:

use iLCSoft now

and

join Key4hep development

Contacts: frank.gaede@desy.de (DESY, iLCSoft/Key4hep), andre.philippe.sailer@cern.ch (CERN, iLCSoft/Key4hep/iLCDirac), paolo.giacomelli@bo.infn.it (Bologna, FCC-SW/Key4hep), manqi.ruan@ihep.ac.cn (IHEP, CEPC), philipp.roloff@cern.ch (CERN, physics studies iLCSoft/Key4hep), jenny.list@desy.de (DESY, physics studies iLCSoft/Key4hep)

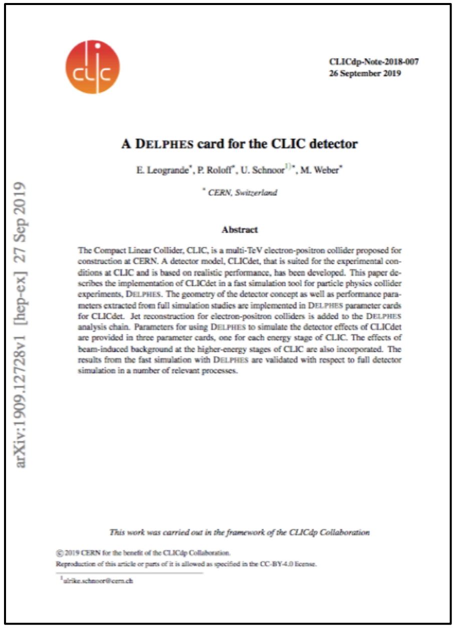
Tools for CLIC sensitivity studies

- A Delphes card for the CLICdet detector model is well-documented and has already been extensively used:

  Whizard settings for CLIC:
  https://gitlab.cern.ch/CLICdp/DetectorSoftware/clic-whizard2-settings

  CLICdet Delphes card description and validation:
  https://arxiv.org/abs/1909.12728

  Further information on the use of the CLICdet Delphes card can be found here:
  https://twiki.cern.ch/twiki/bin/view/CLIC/CLICdetDelphesInstructions



CLICdp-Note-2018-007
26 September 2019

arXiv:1909.12728v1 [hep-ex] 27 Sep 2019

A DELPHES card for the CLIC detector

E. Leogrande*, P. Roloff*, U. Schnoor[1]*, M. Weber*

* CERN, Switzerland

Abstract

The Compact Linear Collider, CLIC, is a multi-TeV electron-positron collider proposed for construction at CERN. A detector model, CLICdet, that is suited for the experimental conditions at CLIC and is based on realistic performance, has been developed. This paper describes the implementation of CLICdet in a fast simulation tool for particle physics collider experiments, DELPHES. The geometry of the detector concept as well as performance parameters extracted from full simulation studies are implemented in DELPHES parameter cards for CLICdet. Jet reconstruction for electron-positron colliders is added to the DELPHES analysis chain. Parameters for using DELPHES to simulate the detector effects of CLICdet are provided in three parameter cards, one for each energy stage of CLIC. The effects of beam-induced background at the higher-energy stages of CLIC are also incorporated. The results from the fast simulation with DELPHES are validated with respect to full detector simulation in a number of relevant processes.

This work was carried out in the framework of the CLICdp Collaboration

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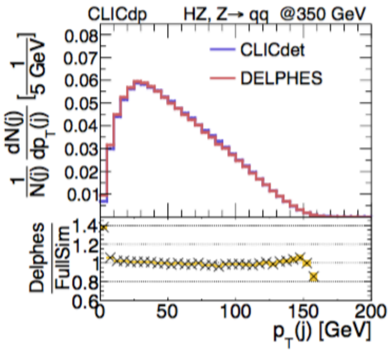
- b-tagging working points
- jet reconstruction choices
- etc.

Delphes jet p_T validation in HZ events



- If you are interested in using the full simulation or have questions on Whizard and Delphes for CLICdet, you are very welcome to contact us:
  clicdp-snowmass-samples-contacts@cern.ch

CLIC perspective

- CLIC is a mature project, ready to provide a Higgs factory and subsequent multi-TeV lepton machine
  - precision measurements
  - sensitivity to elusive signatures
  - extended energy/mass reach

- CERN is continuing investment in CLIC accelerator R&D for the next 5 years

- So far, CLIC physics has provided the most detailed studies for high-energy lepton collisions, where interest is increasing

- You are strongly encouraged to consider high-energy lepton collisions in the Snowmass physics roadmap, and look at your favourite model / new benchmark at the CLIC energies using the tools we have provided!

Thank you!